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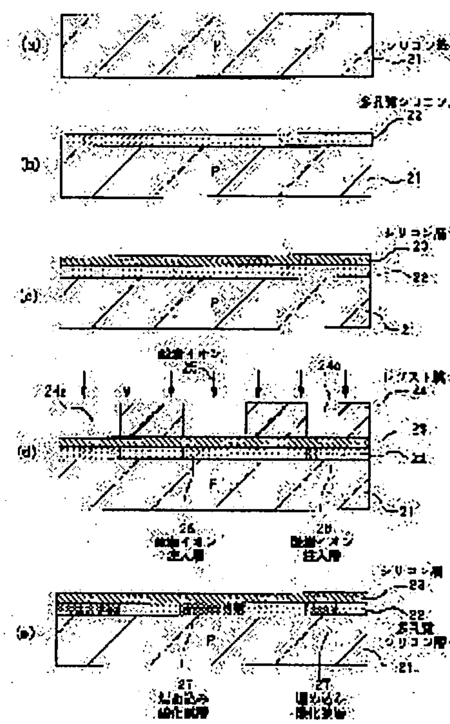
(54) MANUFACTURE OF SEMICONDUCTOR SUBSTRATE

(57)Abstract:



PROBLEM TO BE SOLVED: To prevent the increase of volume due to oxidizing reaction and the generation of crystal defect and unevenness on the substrate surface which are to be caused by stress, when a buried oxide film layer is formed in a semiconductor substrate.
SOLUTION: On a silicon substrate 21, a porous silicon layer 22 is formed by anodic formation, and silicon is epitaxially grown on the porous silicon layer 22, thereby forming a single-crystal silicon layer 23. On the silicon substrate 21, a resist film 24 having an aperture 24a is formed, and by using the resist film 24 as a mask, oxygen ions 25 are implanted through the single-crystal silicone layer 23, thereby forming a plurality of oxygen ions implanted layers 26 in the porous silicon layer 22. After the resist film 24 is eliminated, heat treatment is performed. Hence the ion-implanted oxygen reacts with silicon, and a plurality of buried oxide film layers 27 are selectively formed in the silicon substrate 21.

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CLAIMS

[Claim(s)]
[Claim 1] The process which is the manufacture approach of the semi-conductor substrate which embeds in said semi-conductor substrate and forms an oxidizing zone by performing heat treatment after pouring in oxygen ion into a semi-conductor substrate, and forms a porosity silicon layer in the front face of said semi-conductor substrate, The process which forms a single-crystal-silicon layer on said porosity silicon layer, and after forming said single-crystal-silicon layer The manufacture approach of the semi-conductor substrate characterized by including the process which said porosity silicon layer is oxidized, embeds and forms an oxidizing zone by heat-treating by injecting oxygen ion into a porosity silicon layer, and following it through said single-crystal-silicon layer.
[Claim 2] The manufacture approach of the semi-conductor substrate according to claim 1 which forms the ionic membrane-proof which has opening partially on this single-crystal-silicon layer after forming a single-crystal-silicon layer on said porosity silicon layer, pours in oxygen ion by using this ionic membrane-proof as a mask, and is characterized by embedding in a semi-conductor substrate and forming an oxidizing zone alternatively by heat-treating continuously.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manufacture approach of a semi-conductor substrate of embedding inside and having an oxide film.
[0002]
[Description of the Prior Art] In order to realize the three-dimensional structure for making the improvement in the engine performance of a semiconductor device, and the densification of a device attain, it is SOI (Silicon On Insulator). A technique is to a base. As this SOI technique, an insulator layer is formed on a semi-conductor substrate (silicon wafer) with the approach of carrying out epitaxial growth of the silicon on an insulating substrate (sapphire), and there is a method of growing up the single crystal of silicon on this insulator layer.
[0003] Conventionally, as a technique which forms an insulator layer on this silicon wafer, oxygen ion is injected into a silicon substrate and there is the approach of forming an insulator layer layer (pad oxide-film layer) by making it heat-treat and react.
[0004] Drawing 3 (a) With reference to - (c), the manufacture approach of the conventional SOI substrate is explained in order of a process. First, the silicon substrate (silicon wafer) 1 as shown in drawing 3 (a) is prepared. And as shown in drawing 3 (b), the oxygen ion 2 is poured into the field of the predetermined depth of this silicon substrate 1, and the oxygen ion-implantation layer 3 is formed. The injection rate of the oxygen ion 2 sets 1018-/cm2 and the impregnation depth to about 100nm. Next, embedding oxide-film layer (silicon oxidation membrane layer) 3a inserted between the silicon substrate 1 and the silicon layer 4 as shown in drawing 3 (c) is formed by heat-treating 1200-1350-degreeC, for example, and making the oxygen and silicon by which the ion implantation was carried out react.
[0005] an above-mentioned approach -- the so-called SIMOX (Separation by IMplantated OXygen) -- it is called law and the crystallinity of the silicon layer 4 on embedding oxide-film layer 3a can be kept good by repeating a heat treatment process by turns like ion grouting.
[0006]
[Problem(s) to be Solved by the Invention] However, by the conventional approach, in a heat treatment process, an oxide film twice [about] the magnitude of the volume of the silicon which reacted will be formed of the reaction of the oxygen and silicon by which the ion implantation was carried out, therefore the silicon of the embedding oxide-film layer 3a circumference will receive stress by it. Therefore, within a silicon substrate 1, the crystal defect was caused and there was a problem of leading to increase of junction leak etc.
[0007] Moreover, the demand which embeds alternatively as application of this SIMOX method at a part of silicon substrate 1, and forms an oxide-film layer may arise. For example, by embedding only directly under [gate electrode] a transistor and forming an oxide film layer, it is strong to a short channel effect, and the component which has about the same S value as SOI can be formed. Or a junction capacitance can be sharply reduced by embedding only directly under a source field and a drain field, and forming an oxide-film layer. moreover, DRAM (Dynamic Random Access Memory) etc. -- by using a SOI

technique only for the memory cell section, junction leak of a cel transistor is reduced and it becomes possible to aim at an improvement of a maintenance property.

[0008] Such a partial embedding oxide-film layer can be formed by the approach shown in drawing 4 (a) - (c). First, the silicon substrate 1 as shown in drawing 4 (a) is prepared, and as shown in drawing 4 (b), the resist film 5 which has opening 5a corresponding to an embedding oxide film stratification schedule field is formed on a silicon substrate 1. Then, the oxygen ion 2 is poured in by using this resist film 5 as a mask, and two or more oxygen ion-implantation layers 3 are alternatively formed in the field of the predetermined depth. Hereafter, after removing the resist film 5, like the above-mentioned approach, it can heat-treat and two or more embedding oxide-film layer (silicon oxidation membrane layer) 3a as shown in drawing 4 (c) can be formed by making the oxygen and silicon by which the ion implantation was carried out react.

[0009] Although a partial embedding oxide-film layer can be easily formed by such approach, also in this approach, in the process which adds heat treatment, in case silicon oxidizes, that volume becomes large, therefore the surrounding silicon of two or more embedding oxide-film layer 3a will receive stress. Therefore, within a silicon substrate 1, the crystal defect was caused and there was a problem of leading to increase of junction leak etc. Furthermore, by this approach, as shown in drawing 4 (c), the uneven section 6 arose on the front face of a silicon substrate 1, and there was a problem of causing trouble to device formation of a back process.

[0010] This invention was made in view of this trouble, and even if it embeds the technical problem in a semi-conductor substrate and it forms an oxide-film layer, it is to offer the manufacture approach of the semi-conductor substrate which sees on the whole, does not produce increase of the volume by oxidation reaction, and does not produce unevenness of the crystal defect by stress, or a front face.

[0011]

[Means for Solving the Problem] Invention according to claim 1 is the manufacture approach of the semi-conductor substrate which embeds in said semi-conductor substrate and forms an oxidizing zone by performing heat treatment, after pouring in oxygen ion into a semi-conductor substrate. The process which forms a porosity silicon layer in the front face of said semi-conductor substrate, and the process which forms a single-crystal-silicon layer on said porosity silicon layer, After forming said single-crystal-silicon layer, the process which said porosity silicon layer is oxidized, embeds and forms an oxidizing zone is included by heat-treating by injecting oxygen ion into a porosity silicon layer, and following it through said single-crystal-silicon layer.

[0012] Invention according to claim 2 forms the ionic membrane-proof which has opening partially on this single-crystal-silicon layer, after forming a single-crystal-silicon layer on said porosity silicon layer in the manufacture approach according to claim 1, it pours in oxygen ion by using this ionic membrane-proof as a mask, by heat-treating continuously, is embedded in a semi-conductor substrate and forms an oxidizing zone alternatively.

[0013] By the manufacture approach of the semi-conductor substrate of this invention, since the impregnation and heat treatment of oxygen ion which let a single-crystal-silicon layer pass are performed and an embedding oxidizing zone is formed after forming a porosity silicon layer in the front face of a semi-conductor substrate and forming a single-crystal-silicon layer on this porosity silicon layer, in a heat treatment process, the volume integral which increased by oxidation reaction of porosity silicon is spent in the space in porosity silicon.

[0014]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained with reference to a drawing.

[0015] The gestalt of the 1st operation [0016] Drawing 1 (a) - (e) expresses the production process of the semi-conductor substrate concerning the gestalt of operation of the 1st of this invention. First, as shown in drawing 1 (a), the semi-conductor substrate 11 of P type, for example, a silicon substrate, (silicon wafer) is prepared. And as shown in drawing 1 (b), the porosity silicon layer 12 of desired thickness (100nm-) is formed in the front face of a silicon substrate 11 by carrying out anodization of the silicon substrate 11 on condition that 2 the current density of 10-80mA/cm into the mixed solution of HF

(50wt%):C2 H5 OH(99.5%) =1:1.
[0017] Next, as shown in drawing 1 (c), on the porosity silicon layer 12, epitaxial growth of the silicon is carried out and thickness forms the about 100nm single-crystal-silicon layer 13. Then, as shown in drawing 1 (d), the oxygen ion 14 is poured in through this single-crystal-silicon layer 13, and the oxygen ion-implantation layer 15 is formed in the porosity silicon layer 12 in a silicon substrate 11. In addition, by this approach, since fluctuation of the below-mentioned volume decreases most, the case where the volume ratio of silicon and oxygen is set to 1:2 needs to optimize the ion injection rate of oxygen so that it may become this ratio. Here, it is 1018-/cm2 about an ion injection rate. What is necessary is just to consider as order.
[0018] Next, as shown in drawing 1 (e), by performing with a 1200-1350-degree temperature [about C] heat treatment, and making the oxygen and silicon which were poured in into the oxygen ion-implantation layer 15 react, it embeds in a silicon substrate 11 and the oxide-film layer (silicon oxidation membrane layer) 16 is formed. By repeating a heat treatment process by turns like such ion grouting, the crystallinity of the single-crystal-silicon layer 13 on the embedding oxide-film layer 16 can be kept good.
[0019] Thus, with the gestalt of this operation, since impregnation and heat treatment of oxygen ion are performed and the embedding oxide-film layer 16 was formed after forming the porosity silicon layer 12 in the front face of a silicon substrate 11 and forming the single-crystal-silicon layer 13 on this porosity silicon layer 12, the volume integral of the silicon which increased by oxidation reaction is spent in the space in the porosity silicon layer 12. For this reason, it is lost that see on the whole, the volume does not increase by oxidation reaction around the embedding oxide film 16, and stress arises to surrounding silicon. Therefore, a crystal defect is caused like before and it is lost that junction leak increases. Moreover, by the approach by the gestalt of this operation, since the oxidation rate of porosity silicon is quick, while heat treatment time amount is shortened compared with the conventional approach, low temperature-ization of heat treatment temperature can be attained.
[0020] The gestalt of the 2nd operation [0021] Next, drawing 2 (a) - (e) explains the gestalt of operation of the 2nd of this invention.
[0022] First, as shown in drawing 2 (a), the semi-conductor substrate 21 of P type, for example, a silicon substrate, (silicon wafer) is prepared. And as shown in drawing 2 (b), a silicon substrate 21 is set in the mixed solution of HF(50wt%):C2 H5 OH(99.5%) =1:1, and it is 2 the current density of 10-80mA/cm. On conditions, the porosity silicon layer 22 of desired thickness (100nm-) is formed in the front face of a silicon substrate 21 by carrying out anodization. Then, as shown in drawing 2 (c), on the porosity silicon layer 22, epitaxial growth of the silicon is carried out and thickness forms the about 100nm single-crystal-silicon layer 23. The process so far is the same as the process of drawing 1 (a) - (c).
[0023] With the gestalt of this operation next, as shown in drawing 2 (d), the resist film 24 which has opening 24a corresponding to an embedding oxide film stratification schedule field is formed on a silicon substrate 21. Then, this resist film 24 is used as a mask, the oxygen ion 25 is poured in through the single-crystal-silicon layer 23, and two or more oxygen ion-implantation layers 26 are alternatively formed in the porosity silicon layer 12.
[0024] Next, as shown in drawing 2 (e), after removing the resist film 24, two or more embedding oxide-film layers (silicon oxidation membrane layer) 27 are alternatively formed in a silicon substrate 11 by performing with a 1200-1350-degree temperature [about C] heat treatment, and making the oxygen and silicon which were poured in into the oxygen ion-implantation layer 26 react. Also in this approach, the crystallinity of the single-crystal-silicon layer 23 on the embedding oxide-film layer 27 can be kept good by repeating a heat treatment process by turns like ion grouting.
[0025] Thus, the porosity silicon layer 22 is formed in the front face of a silicon substrate 21 with the gestalt of this operation. Since two or more embedding oxide-film layers 27 were formed by pouring in oxygen ion alternatively and performing that postheat treatment after forming the single-crystal-silicon layer 23 on this porosity silicon layer 22 The volume integral of the silicon which increased by oxidation reaction as well as the gestalt of the 1st operation is spent in the space in the porosity silicon layer 22. for this reason -- overall -- seeing -- two or more embedding oxide films 27 -- it is lost that the volume

increase by oxidation reaction does not arise around each, and stress arises to surrounding silicon. Moreover, compared with the conventional approach, since the oxidation rate of porosity silicon is quick, while heat treatment time amount is shortened, low temperature-ization of heat treatment temperature can be attained.

[0026] Moreover, with the gestalt of this operation, the front face of a silicon substrate 21 is flat as shown in drawing 2 (e), and it is lost that the uneven section arises of it like before. Therefore, the component of formation of the transistor with which the fault of both SOI by the partial embedding oxide film 27 and bulk was compensated, or SOI and bulk mixed loading can be formed.

[0027] In addition, although explained using the silicon substrates 11 and 21 of P type as a semi-conductor substrate, you may make it use the semi-conductor substrate of N type in the gestalt of the above-mentioned implementation. However, since a hole (electron hole) is needed in order to form a porosity silicone film by the anodization method, in using the semi-conductor substrate of N type, the means of supplying a hole for example, by optical exposure is needed.

[0028]

[Effect of the Invention] Since a porosity silicon layer is formed in the front face of a semi-conductor substrate according to the manufacture approach of a semi-conductor substrate according to claim 1 as explained above, and it embeds by performing the impregnation and heat treatment of oxygen ion which let a silicon layer pass after forming a silicon layer on this porosity silicon layer further and the oxidizing zone was formed, it is lost that stress starts the crystal of the embedding oxide-film layer circumference of a semi-conductor substrate. Therefore, what spoils the crystallinity of a semi-conductor substrate is lost, and increase of junction leak etc. can be prevented.

[0029] Moreover, according to the manufacture approach of a semi-conductor substrate according to claim 2, a silicon layer is formed on a porosity silicon layer. By using this ionic membrane-proof as a mask, and heat-treating by pouring in oxygen ion through a silicon layer and continuing, after forming the ionic membrane-proof which has opening partially on this silicon layer Since two or more embedding oxidizing zones were formed alternatively, while what spoils the crystallinity of a semi-conductor substrate is lost and being able to prevent increase of junction leak etc. A possibility that concave heights may occur on the surface of a substrate is lost, and trouble is lost in the device formation process of a back process.

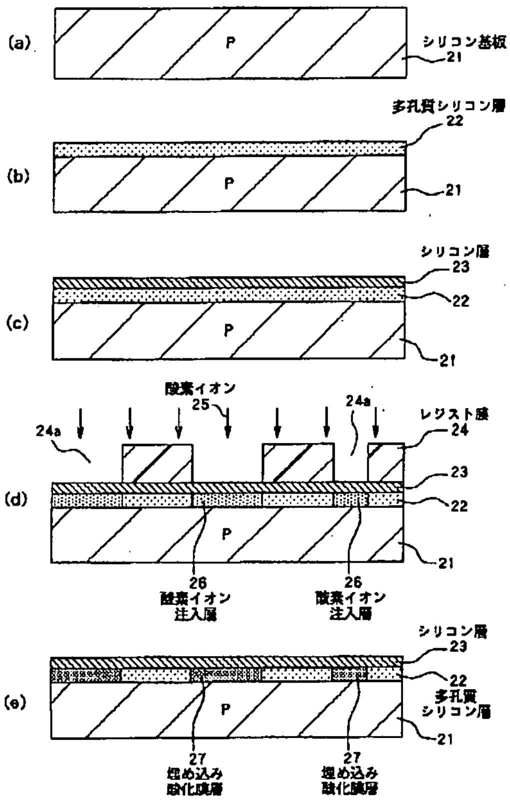
[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is a sectional view for explaining the production process by the gestalt of operation of the 1st of this invention.
[Drawing 2] It is a sectional view for explaining the production process by the gestalt of operation of the 2nd of this invention.
[Drawing 3] It is a sectional view for explaining the production process of a conventional method.
[Drawing 4] It is a sectional view for explaining other production processes of a conventional method.
[Description of Notations]
11 21 Semi-conductor substrate
12 22 Porosity silicon layer
13 23 Silicon layer (epitaxial layer)
14 25 Oxygen ion
15 26 Oxygen ion-implantation layer
16 27 Embedding oxide-film layer
24 Resist Film (Ionic Membrane-proof)

[Translation done.]

Drawing selection Representative drawing



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